CLAIMS

What is claimed is:

1. An assay method comprising:

providing a sample that is suspected of containing a target polynucleotide;

providing a polycationic multichromophore that upon excitation is capable of transferring energy to a signaling chromophore;

providing an anionic sensor polynucleotide that is single-stranded and is complementary to the target polynucleotide, said sensor polynucleotide conjugated to the signaling chromophore, wherein said sensor polynucleotide interacts with the multichromophore and emitted light can be produced from the signaling chromophore upon excitation of the multichromophore in the absence of target polynucleotide, and wherein a greater amount of emitted light is produced from the signaling chromophore upon excitation of the multichromophore in the presence of target polynucleotide;

contacting the sample with the sensor polynucleotide and the multichromophore in a solution under conditions in which the sensor polynucleotide can hybridize to the target polynucleotide, if present;

applying a light source to the solution that can excite the multichromophore; and

detecting whether the light emitted from the signaling chromophore is increased in the presence of sample.

2. The method of claim 1, wherein the multichromophore comprises a structure selected from a saturated polymer, a conjugated polymer, an aggregate of conjugated molecules, a dendrimer, and a semiconductor nanocrystal.

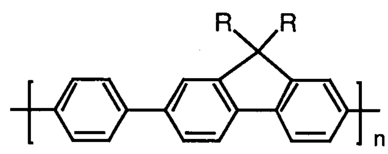
3. The method of claim 2, wherein the multichromophore comprises a saturated polymer.

4. The method of claim 2, wherein the multichromophore comprises a dendrimer.

5. The method of claim 2, wherein the multichromophore comprises a semiconductor nanocrystal.

6. The method of claim 2, wherein the multichromophore comprises a conjugated molecule.

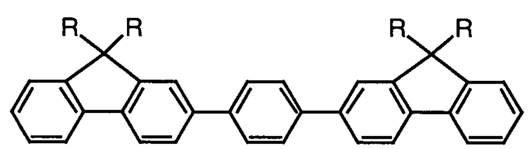
7. The method of claim 6, wherein the conjugated polymer has the structure



1 $-R = -(CH_2)_6\overset{\oplus}{N}Me_3\overset{\ominus}{I}$

8. The method of claim 2, wherein the multichromophore is an aggregate of conjugated molecules.

9. The method of claim 8, wherein the aggregate comprises molecules having the structure



2 $-R = -(CH_2)_6\overset{\oplus}{N}Me_3\overset{\ominus}{I}$

10. The method of claim 1, wherein the sample is contacted with the sensor polynucleotide and the multichromophore in the presence of a sufficient amount of an organic solvent to decrease hydrophobic interactions between the sensor polynucleotide and the multichromophore.

11. The method of claim 1, wherein the sample is contacted with a plurality of different sensor polynucleotides having corresponding different sequences, said different sensor polynucleotides comprising a corresponding different signaling chromophore, wherein each of said different sensor polynucleotides can selectively hybridize to a corresponding different target polynucleotide.

12. The method of claim 1, wherein the signaling chromophore is a fluorophore.

13. The method of claim 12, wherein the fluorophore is selected from a semiconductor nanocrystal, a fluorescent dye, and a lanthanide chelate.

14. The method of claim 13, wherein the fluorophore is a semiconductor nanocrystal.

15. The method of claim 13, wherein the fluorophore is a fluorescent dye.

16. The method of claim 15, wherein the fluorescent dye is fluorescein.

17. The method of claim 13, wherein the fluorophore is a lanthanide chelate.

18. The method of claim 1, wherein the target polynucleotide is DNA.

19. The method of claim 1, wherein the target polynucleotide is RNA.

20. The method of claim 1, wherein the sample comprises single-stranded target polynucleotide.

21. The method of claim 1, wherein the sample comprises double-stranded target polynucleotide.

22. The method of claim 1, wherein the target polynucleotide is produced via an amplification reaction.

23. A polynucleotide sensing solution comprising:

a signaling chromophore; and

a polycationic multichromophore that is capable of transferring energy to the signaling chromophore upon excitation when brought into proximity thereto, wherein a greater amount of energy can be produced from the signaling chromophore in the presence of the polynucleotide being sensed when the multichromophore is excited.

24. A kit for assaying a sample for a target polynucleotide comprising:

a sensor polynucleotide that is single-stranded and is complementary to the target polynucleotide;

a signaling chromophore;

a polycationic multichromophore that is capable of transferring energy to the signaling chromophore upon excitation when brought into proximity thereto, wherein said sensor polynucleotide interacts with the multichromophore and a detectibly greater amount of emitted light is produced from the signaling chromophore upon excitation of the multichromophore in the presence of target polynucleotide; and

a housing for retaining the reagents of the kit.

25. The method of claim 1, wherein light emitted from the signaling chromophore above a threshold level indicates that the target polynucleotide is present in the sample.

26. The method of claim 1, wherein the amount of light emitted from the signaling chromophore is quantitated and used to determine the amount of the target polynucleotide in the sample.

27. The method of claim 12, wherein the fluorophore is a green fluorescent protein.

28. The method of claim 1, wherein the target polynucleotide is not amplified.

29. The method of claim 1, wherein the method is performed on a substrate.

30. The method of claim 29, wherein the substrate is selected from the group consisting of a microsphere, a chip, a slide, a multiwell plate, an optical fiber, an optionally porous gel matrix, a photodiode, and an optoelectronic device.

31. The method of claim 30, wherein the substrate is a slide.

32. The method of claim 30, wherein the substrate is an optoelectronic device.

33. The method of claim 30, wherein the substrate is an optionally porous gel matrix.

34. The method of claim 33, wherein the substrate is a sol-gel.

35. The method of claim 30, wherein the substrate is nanoaddressable.

36. The method of claim 30, wherein the substrate is microaddressable.

37. The method of claim 30, wherein the substrate is conjugated to a plurality of different sensor polynucleotides having corresponding different sequences, wherein each of said different sensor polynucleotides can selectively hybridize to a corresponding different target polynucleotide.

38. The method of claim 1, wherein the method comprises performing fluorescence *in situ* hybridization (FISH).

39. The method of claim 22, wherein the amplification reaction comprises a polymerase chain reaction.

40. The method of claim 1, further comprising contacting the sample in a solution with the sensor polynucleotide, the multichromophore and a second signaling chromophore that can absorb energy from the signaling chromophore in the presence of target and emit light, and wherein detecting whether the light emitted from the signaling chromophore is increased in the presence of sample comprises detecting whether the light emitted from the second signaling chromophore is increased in the presence of sample.

41. The method of claim 40, wherein the second signaling chromophore is a polynucleotide-specific dye.

42. A signaling complex formed by the method of claim 1.

43. The complex of claim 42, further comprising a second signaling chromophore.

44. The polynucleotide sensing solution of claim 23, further comprising a second signaling chromophore that can absorb energy from the signaling chromophore in the presence of target and emit light.

45. The polynucleotide sensing solution of claim 44, wherein the second signaling chromophore is a polynucleotide-specific dye.

46. A substrate-bound complex formed by the method of claim 29.

47. The substrate-bound complex of claim 46, further comprising a second signaling chromophore.

48. The kit of claim 24, further comprising a second signaling chromophore that can absorb energy from the signaling chromophore in the presence of target and emit light.

49. The kit of claim 48, wherein the second signaling chromophore is a polynucleotide-specific dye.

50. The kit of claim 24, further comprising instructions provided with said housing that describe how to use the components of the kit to assay the sample for the target polynucleotide.

51. A sensing complex comprising:

a sensor polynucleotide that is single-stranded and is complementary to a target polynucleotide, said sensor polynucleotide attached to a signaling chromophore;

a polycationic multichromophore that is capable of transferring energy to the signaling chromophore upon excitation when brought into proximity thereto, wherein said sensor polynucleotide interacts with the multichromophore and emitted light can be produced from the signaling chromophore upon excitation of the multichromophore in the absence of target polynucleotide, and wherein a greater amount of emitted light is produced from the signaling chromophore upon excitation of the multichromophore in the presence of target polynucleotide.

52. The polynucleotide sensing solution of claim 23, further comprising a sensor polynucleotide that is single-stranded and is complementary to the target polynucleotide.

53. The polynucleotide sensing solution of claim 23, wherein the signaling chromophore is a polynucleotide-specific dye that can absorb energy from the multichromophore in the presence of target and emit light.

54. The polynucleotide sensing solution of claim 23, wherein the signaling chromophore is a polynucleotide-specific dye that can absorb energy from the multichromophore in the presence of target and transfer energy to a second signaling chromophore conjugated to a sensor polynucleotide which then emits light.

55. The method of claim 3, wherein the saturated polymer is attached to luminescent dyes.